

Variation in Milk Urea Nitrogen

Marisa R. Joldrichsen

Abstract

Milk urea nitrogen (MUN) is commonly used as an indicator of protein utilization by the dairy cow, and it has been used in some countries as a reference for the amount of N excreted by dairy animals for its environmental implications. The purpose of this study was to investigate some factors that may effect the concentrations of MUN. MUN was evaluated using Dairy Herd Improvement data on individual cows (n=1325) that had been collected from Ohio herds (n=22) between January 2015 and July 2016. The data collected included herd, cow, breed, date of milk sampling, days in milk (DIM), milking frequency, milk yield, milk fat percentage, milk protein percentage, somatic cell score (SCS), and MUN. Correlation among variables and analysis of variance were conducted using SAS (2004). The PROC Mixed Model of SAS was used with farm and cow as random variables and DIM, milk yield, fat, protein, and SCS as the independent variables. There was a positive correlation between fat percentage present in the milk and MUN ($r = 0.18$, $P < 0.0001$). There was a negative correlation between SCS and MUN ($r = -0.13$, $P < 0.0001$). MUN was highest from September-November and lowest from March-May ($P < 0.0001$). Jersey cows had about 2 mg/dL higher ($P < 0.0001$) MUN than Holstein cows. MUN was also higher ($P < 0.001$) with 3x versus 2x (14.62 vs 11.12 mg/dL) a day milking's. The resulting equation from the variables to estimate MUN was:

$$\text{MUN(mg/dL)} = 12.54 + (\text{DIM} * 0.001291) + (\text{milk, kg/day} * 0.00284) + (\text{fat, \%} * 0.488) - (\text{protein, \%} * 1.0123) - (\text{SCS} * 0.1462).$$
 These findings suggest that MUN concentrations

can be effected by many factors at the farm level in addition to nutritional feeding, and that it can be predicted from several production variables. Using this information can help dairy producers to best maximize profitability and reduce N excretion.

Introduction

Milk urea nitrogen is a measure of the amount of urea found in the milk of a lactating dairy cow. It is commonly used by producers as an indicator of protein utilization by the cow in the rumen. It can also be used as an indicator of how much urea is found in the blood and in the urine that is excreted by a dairy cow. The relationship between MUN and urea excreted in the urine is linear over a wide range of MUN levels, and this relationship is seen in both major breeds, Holstein and Jersey, of dairy cows (Kauffman & St-Pierre, 2001). With MUN and urea excreted through urine having this linear relationship, many countries have started to use MUN as a reference for the amount of urea excreted by the dairy cow for its environmental implications. With the heavy emphasis on the environment and the effects of agriculture on the environment, the purpose of this study was to look at many different factors that may effect the concentrations of MUN at the farm level. The hypothesis for this experiment was that MUN will be affected by a variety of different production variables in both positive and negative ways.

Materials and Methods

MUN was evaluated using Dairy Herd Improvement (DHI) data on 1325 different dairy cows from 22 different Ohio herds. These data were collected between January 2015 and July 2016. The data collected by DHI included herd

number, cow number, breed, date of milk sampling, DIM, milking frequency, milk yield, milk fat percentage, milk protein percentage, SCS, and MUN concentrations. These variables were then analyzed using SAS (2004) to determine the variation among the variables and to analyze the variance. The PROC Mixed Model of SAS was used with farm and cow as random variables, and with DIM, milk yield, milk fat percentage, milk protein percentage, and SCS as the independent variables. SAS was used to create a Pearson Correlation coefficients table, which compared all of the variables to each other, and it was used to compile the data to develop an equation that can be used for calculating MUN from known variables. Microsoft Excel was also used for the creation of graphs and tables.

Results and Discussion

There were many different results that were able to be seen through the analysis of all of the variables. All of the variables examined were significantly correlated to MUN, but the correlation coefficients were low as seen in Table 1. The highest correlation with MUN was fat percentage in the milk, $r = 0.18$, $P < 0.0001$ (Table 1). MUN was higher for three times-a-day milking with 14.62 mg/dL, versus two times a day milking with 11.12 mg/dL ($P < 0.001$). It was also observed that the Jersey breed had a higher MUN concentration than the Holstein breed ($P < 0.0001$) (Figure 1). MUN was also highest among the months of September through November and lowest among the months of March through May ($P < 0.0001$) (Figure 1). There was also a negative correlation between somatic cell score and MUN concentrations, $r = -0.13$ with $P < 0.0001$ (Table 1). MUN concentrations followed the lactation curve by peaking shortly after peak milk yield (Figure 2). Finally, the

resulting equation for calculating MUN using the variables presented was: $\text{MUN (mg/dL)} = 12.54 + (\text{DIM} \times 0.001291) + (\text{milk, kg/day} \times 0.00284) + (\text{fat, \%} \times 0.488) - (\text{protein, \%} \times 1.0123) - (\text{SCS} \times 0.1462)$.

Most of these results fit with the research that has already been done on MUN in the past. According to Moore and Varga (1996) the normal or target values for MUN should be between 10 to 15 mg/dL, which fits with our reported value for the calculation of MUN from other values, with a standard value of 12.54 mg/dL. According to Rajala-Schultz and Saville (2003), they also found that MUN levels were lowest during the first months of the lactation and that the MUN levels peaked around the time of peak milk yield, which is similar to our observation as shown in Figure 2. As reported by Wattiaux et al. (2005), Jersey cows have a higher MUN value than Holstein cows, which is similar to our results in Figure 1. They also found that three times-a-day milking of cows results in a higher MUN concentration than two times-a-day milking, which we also found with our analysis. Even with all of these similarities, there were some discrepancies in that most of the research in MUN seems to suggest that MUN concentrations are highest during the spring months (March-May) as seen in a study conducted by Jonker, Kahn, and High (2002), but within this study, we found that MUN concentrations were highest during the fall months (September-November), as shown in Figure 1. This observation may reflect that only few of the farms in our study may have been using pasture in the spring, or in other words, they likely primarily fed a total mixed ration all year. It also reveals that much more research needs to be conducted to discover the real effects of urea excretion on the environment and more conclusive data on

what months have the highest amount of urea excretion. These similarities and discrepancies show the need for more research into MUN concentrations and the possible implications for the farm and for the environment.

Conclusion

With these data and the subsequent analyses, it suggests that MUN concentrations can be affected by many different factors at the farm level in addition to nutritional feeding. MUN concentrations can also be predicted from several different production values. These findings also suggest that when looking at estimating MUN, all of the values together play a different role in MUN concentrations than when the variables are looked at separately (e.g. correctional analysis). It also was observed that MUN concentrations changed depending on the time of the year, and that cows in lactation from September-November had higher MUN concentrations. This does not necessarily relate to the intake of pasture in the fall because MUN concentration in the spring was among the lowest of the seasons. MUN increased with days in milk as intake of protein increased and then declined at a slower rate than milk yield, likely because protein intake remained rather high during the time that its requirement was decreasing. Using this information and further studies can help dairy producers best maximize profitability and reduce nitrogen excretion into the environment.

References

- Jonker, J., Kohn, R., and High, J. (2002). Use of Milk Urea Nitrogen to Improve Dairy Cow Diets. *Journal of Dairy Science*, 85(4), 939-946. doi:10.3168/jds.s0022-0302(02)74152-0
- Kauffman, A., and St-Pierre, N. (2001). The Relationship of Milk Urea Nitrogen to Urine Nitrogen Excretion in Holstein and Jersey Cows. *Journal of Dairy Science*, 84(10), 2284-2294. doi:10.3168/jds.s0022-0302(01)74675-9
- Moore, D.A., and Varga, G. (1996). BUN and MUN: Urea nitrogen testing in dairy cattle. *Comp. Cont. Edu. Pract. Vet.* 18:712-721.
- Rajala-Schultz, P., and Saville, W. (2003). Sources of Variation in Milk Urea Nitrogen in Ohio Dairy Herds. *Journal of Dairy Science*, 86(5), 1653-1661. doi:10.3168/jds.s0022-0302(03)73751-5
- SAS Institute. 2004. SAS/STAT 9.1 User's Guide. SAS Inst. Inc., Cary, NC.
- Wattiaux, M., Nordheim, E., & Crump, P. (2005). Statistical Evaluation of Factors and Interactions Affecting Dairy Herd Improvement Milk Urea Nitrogen in Commercial Midwest Dairy Herds. *Journal of Dairy Science*, 88(8), 3020-3035. doi:10.3168/jds.s0022-0302(05)72982-9

Acknowledgements

I would like to thank DHI for providing me with these records and Dr. Eastridge for helping me with this project, every step of the way.

	Lactation	Season	DIM	Milk Yield	Fat %	Protein %	SCS	Milking x	MUN
Lactation	1.00000								
Season	-0.01350 0.0340	1.00000							
DIM	-0.03077 <0.0001	-0.0309 <0.0001	1.00000						
Milk Yield	0.19735 <0.0001	-0.0105 0.0981	-0.3685 <0.0001	1.00000					
Fat %	0.01155 0.0697	-0.0794 <0.0001	0.03600 <0.0001	-0.30203 <0.0001	1.00000				
Protein %	-0.07590 <0.0001	-0.0599 <0.0001	0.34806 <0.0001	-0.53254 <0.0001	0.47436 <0.0001	1.00000			
SCS	0.18368 <0.0001	0.01591 0.0125	0.08958 <0.0001	-0.18144 <0.0001	0.05440 <0.0001	0.12706 <0.0001	1.00000		
Milking x	-0.01093 0.0860	0.03687 <0.0001	-0.0116 0.0674	0.26660 <0.0001	-0.11120 <0.0001	-0.17208 <0.0001	0.02660 <0.0001	1.00000	
MUN	-0.07806 <0.0001	0.07614 <0.0001	-0.0417 <0.0001	-0.00974 0.1261	0.18875 <0.0001	0.08249 <0.0001	-0.13311 <0.0001	-0.05437 <0.0001	1.00000

Table 1- Pearson correlation coefficient table.

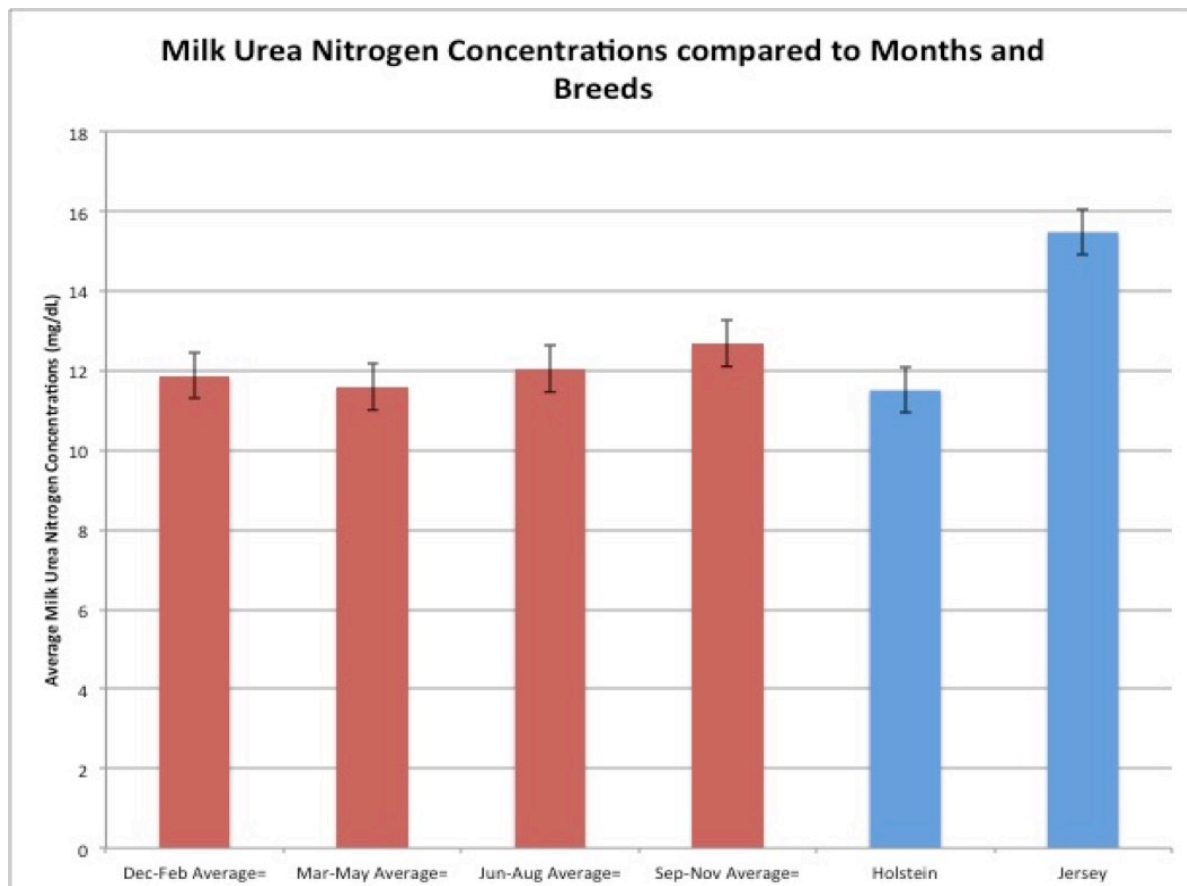


Figure 1- MUN concentrations (mg/dL) by season of the year and for breed.

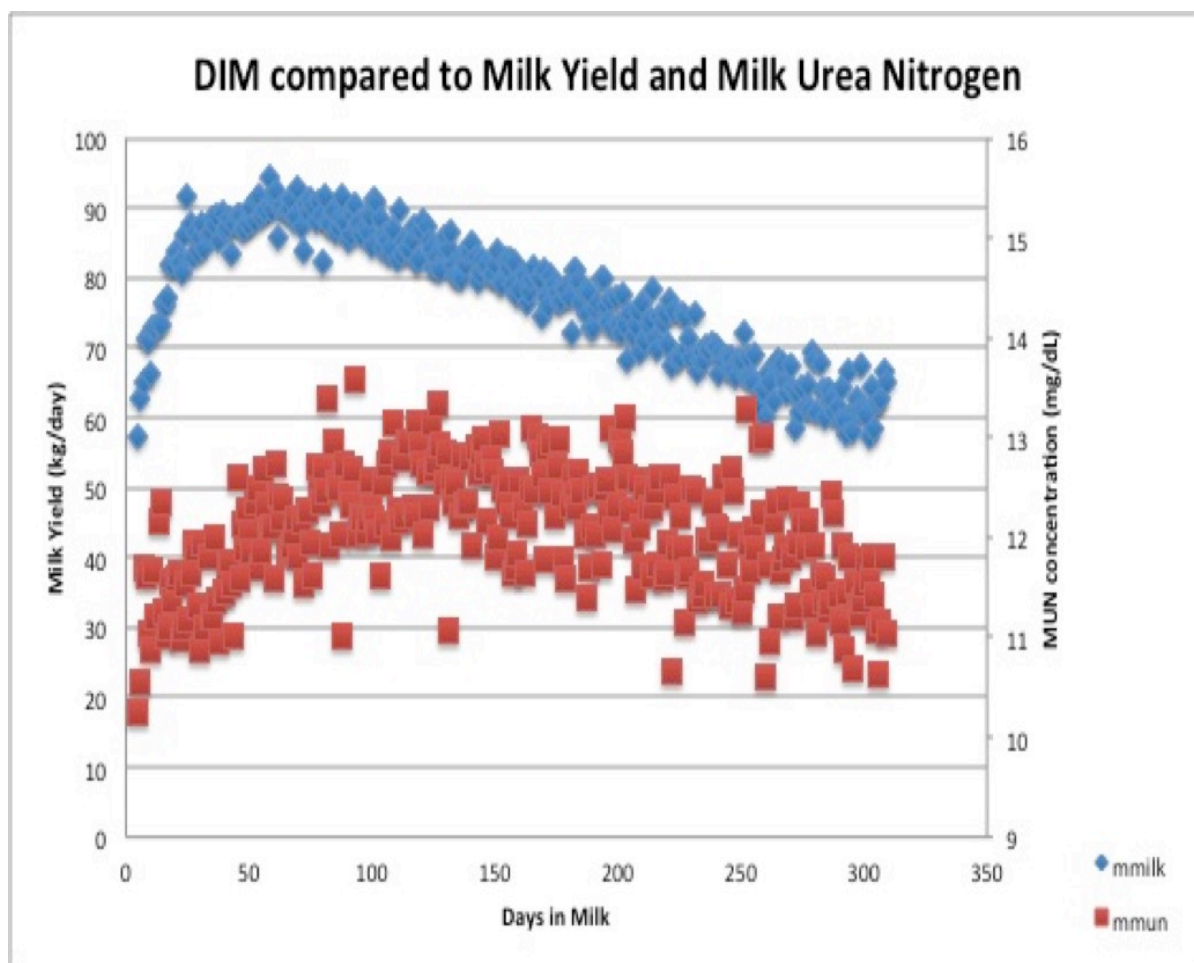


Figure 2- MUN (mg/dL) and milk yield by days in milk.